

AMENDMENTS TO THE SPECIFICATION AND ABSTRACT

Please amend the paragraph beginning on page 1, line 25 as follows:

On the other hand, the latter pre-treatment process is disadvantageous in that the plating solution and the seed copper layer on the substrate are not brought into contact with each other under constant conditions. Hence, additives such as a copper separation accelerator and a copper separation inhibitor contained in the plating solution tend to suffer initial adsorption irregularities to the surface of the seed copper layer and activation irregularities thereof. Further, the substrate is susceptible to the specific adsorption of a component caused by a black film on a soluble anode positioned in confronting relation to the substrate. As a consequence, the metal copper is abnormally separated out locally on the surface of the substrate, causing the substrate to have a stained appearance. When the metal copper is nonuniformly and abnormally separated out (i.e., deposited) locally, the crystal orientation of the copper and the thickness of the copper layer become irregular, making it difficult for the substrate to be polished to a flat finish by a chemical mechanical polishing (CMP) process after the plating process.

Please amend the paragraph beginning on page 2, line 16 as follows:

Further, the conventional copper plating process is problematic in that the thickness of the deposited copper film differs from location to location because of the presence of the interconnection pattern (i.e., fine interconnection grooves). According to this problem, specifically, the thickness of the deposited copper film is much larger in an area where fine interconnections are closely spaced (i.e., a high-density area with closely-spaced grooves) than in an area which is free of fine interconnections (a groove-free low density area). The hump, which is the difference between the thickness of the deposited copper film in the area where fine interconnections are closely spaced and the thickness of the deposited copper film in the area free of fine interconnections, may reach 1 μm . The hump presents difficulty in polishing the deposited copper film to a flat finish in the chemical mechanical polishing (CMP) process subsequent to the plating process. Any undesirable remaining copper film in the area where fine

interconnections are closely spaced tends to cause a short circuit between the interconnections. Thus, the yield of substrates is likely to be lowered.

Please amend the paragraph beginning on page 3, line 2 as follows:

It is therefore an object of the present invention to provide a method and apparatus for plating a substrate with copper which can prevent metal copper from being separated out (i.e., deposited) locally on the surface of the substrate, allow a plated copper film to be easily planarized in a chemical mechanical polishing (CMP) process after the plating process, and finish the substrate to a mirror-like glossy surface with a relatively simple facility and a process.

Please amend the paragraph beginning on page 3, line 21 as follows:

The substrate may be brought into contact with the processing solution by directly dipping the substrate into the processing solution in a tank, spraying the processing solution over the substrate while the substrate is being rotated in a horizontal plane at a high speed as with a spin dryer, or supplying the processing solution by a pump into a dedicated dipping chamber in which the substrate is set at a predetermined position. When the substrate is thus brought into the processing solution, a thin film of the organic substance and/or the sulfur compound is coated on the processed surface of the substrate. Extra processing solution is preferably removed from the substrate, and then the substrate is plated with copper according to a conventional process. In this manner, metal copper is prevented from being separated out (deposited) locally on the processed surface of the substrate, and the substrate is plated to provide a mirror-like glossy surface. Further, the size of humps in an area of closely spaced interconnections on the processed surface of the substrate can be suppressed.

Please amend the paragraph beginning on page 6, line 22 as follows:

The current supplied in the electrolytic etching process may be a direct current or a pulsed current (so-called PR pulse). The etched depth is proportional to the supplied amount of current (the product of the magnitude of the current and the time in which the current is passed). The

current is supplied to the substrate at a current density ranging from 1 to 30 mA/cm² for a period of time ranging from about 0.5 to 30 seconds. The concentration of sulfuric acid employed in the chemical etching process is preferably in the range of about 0.5 to 30 %, and the substrate is held in the sulfuric acid for a period of time ranging from about 1 to 30 seconds. The sulfuric acid is a most popular additive added to the plating solution, and can easily be handled from the standpoint of the composition management of the plating solution. The thickness of the plated film that is etched away (i.e., the reduction amount) is 1 nm or more for achieving any appreciable effect of the etching process, and is preferably in the range of about 10 to 50 nm.

Please amend the paragraph beginning on page 8, line 17 as follows:

As shown in FIG. 1, a plating apparatus 1 comprises a loading unit 4 and an unloading unit 5 for loading and unloading wafer cassettes (not shown) housing substrates (not shown) such as semiconductor wafers to be processed, a delivery arm 8 and a movable delivery arm 9 for delivering substrates one at a time, a pair of coating tanks (processing tanks) 2 for processing the surface of a substrate with a processing solution, a plurality of plating tanks 3 for plating substrates, a cleaning unit 6 for cleaning substrates, and a pair of rinsing and drying units 10 for rinsing and drying substrates. Each of the coating tanks 2 and the plating tanks 3 may be a batch-type tank for processing a plurality of substrates simultaneously, or may be an individual processing tank for processing substrates individually one at a time. Further, each of the coating tanks 2 and the plating tanks 3 may be a dip-type tank for steadily holding a plating solution or a processing solution, or a tank for being supplied with and discharging a plating solution or a processing solution each time a plurality of substrates or a substrate is processed. The delivery arm 8 is used to handle clean substrates, and the movable delivery arm 9 is used to deliver substrates to be plated or processed. In other words, the tanks for the processing liquid and plating solution are separated and located in the same horizontal plane (see Fig. 1), so the movable delivery arm 9 can transfer the substrate between the tank units.

Please amend the paragraph beginning on page 18, line 33 as follows:

According to the present invention, as described above, since copper is prevented from being abnormally separated out (i.e., deposited) while a substrate is being plated with copper, the substrate can be plated with a copper film having a uniform thickness while reducing the size of any undesirable humps. Copper can be embedded well for fine interconnections, producing copper interconnections free of defects such as voids. As a result, the plated substrate can subsequently be easily polished by the chemical mechanical polishing process, so that the yield of LSI circuits with copper interconnections can be increased. Therefore, the cost of LSI circuit fabrication can be greatly be lowered. Accordingly, the method and the apparatus for plating a substrate with copper according to the present invention are highly useful and effective in the industry of semiconductor fabrication.